

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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THE LOW -TEMPERATURE SOLUBILITY OF TECHNICAL
XYLIDINES IN AVIATION GASOLINE

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MEMORANDUM REPORTTHE LOW-TEMPERATURE SOLUBILITY OF TECHNICAL
XYLIDINES IN AVIATION GASOLINE

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SUMMARY

Tests were made to determine the low-temperature solubility of technical xylidines in aviation gasoline. The tests included measuring the cloud point, or incipient separation temperature, at several concentrations of technical xylidines in a 65-octane-number clear gasoline without aromatics and with aromatics added in various percentages up to 15 percent by volume and a grade 130, specification AN-F-28, amendment 2, gasoline. Cloud points were determined as a function of concentration of xylidines in the gasolines described with an experimental reproducibility of $\pm 1.5^{\circ}$ C. The concentrations of xylidines that gave a cloud point of -60° C as found by interpolation of the experimental data were:

<u>Concentration of xylidines (percent by weight)</u>	<u>Fuel</u>
3.7	Extracted grade 65
5.0	Grade 65 as delivered
7.3	Extracted grade 65 containing 5 percent by volume of mixed aromatics
Over 10	Grade 65 containing 10 and 15 percent by volume of mixed aromatics; grade 130

From the results it was concluded that:

1. Technical xylidines in quantities up to 3.5 percent by weight may be added to hydrocarbon fuels similar to those used in this investigation with no likelihood that separation will occur at -60° C.
2. The presence of aromatic hydrocarbons in the fuel increases the solubility of xylidines.

INTRODUCTION

The work reported herein covers the solubility of technical xylidines in aviation gasoline at low temperatures, especially at -60°C , and is part of a series of tests to determine the suitability of xylidines as an added antiknock component in aircraft-engine fuel.

Specifically, cloud point, or incipient separation temperature, was determined for each of several concentrations of technical xylidines in gasoline. Several gasolines were selected for the tests, both to determine the effect of aromatic content on solubility of xylidines and to represent typical military aircraft-engine fuel.

The investigation was conducted at the National Advisory Committee for Aeronautics, Aircraft Engine Research Laboratory, Cleveland, Ohio, during May 1943.

APPARATUS AND TEST PROCEDURE

Apparatus. - Figure 1 illustrates the apparatus used. A glass gasoline sample tube 30 by 2.5 centimeters was provided with a vent and drying tube, an air-motor-driven glass stirrer rotating in a brass bushing, and a three-junction iron-constantan thermopile in a glass well. The gasoline sample tube was held in place with a stopper in a 25 by 7 centimeter Dewar flask through which acetone as a coolant was circulated by means of a centrifugal pump. The coolant was circulated through approximately 35 feet of copper tubing coil in a kerosene - dry ice refrigerating bath. The coolant temperature was regulated by means of a valved bypass around the refrigerating bath. A thermometer in a well in the coolant line permitted observation of the coolant temperature. The Dewar flask was supported in an insulating box provided with windows. A small quantity of phosphorous pentoxide placed in the bottom of the insulating box as a drying agent prevented condensation of moisture on the walls of the glass Dewar flask. The three-junction iron-constantan thermopile was used to measure the gasoline sample temperature in the usual manner with distilled water ice as the reference temperature. Calibration of the thermopile was performed against a platinum resistance thermometer, which had been calibrated by the National Bureau of Standards.

Samples. - The analytical balance was used to make up test samples of technical xylidines in the following gasolines:

1. Grade 65, specification AN-VV-F-756, amendment 2.
2. Grade 65 with the aromatic hydrocarbons extracted.

3. Extracted grade 65 to which was added 5 percent by volume of aromatic mixture consisting of five parts xylene, one part toluene, and two parts cumene.
4. Extracted grade 65 to which was added 10 percent by volume of an aromatic mixture consisting of five parts xylene, one part toluene, and two parts cumene.
5. Grade 65 as delivered to which was added 15 percent by volume of an aromatic mixture consisting of five parts xylene, one part toluene, and two parts cumene.
6. Grade 130, specification AN-F-28, amendment 2.

The grade 65 fuel as delivered was a clear gasoline and contained 4.5 percent aromatic hydrocarbons, approximately 60 percent of which was benzene. The grade 130 fuel contained approximately 15 percent aromatic hydrocarbons as well as tetraethyl lead, inhibitor, and dyes.

Table I lists the properties of the technical xylidines used. Technical xylidines is a mixture comprising five of the six possible xylidines.

TABLE I
PROPERTIES OF TECHNICAL XYLIDINES

A.S.T.M. distillation, °C:	
First drop	160
10 percent	209
30	209.5
50	210
70	210
90	210
End point	212
Specific gravity, 25° C/4° C	0.972
Refractive index, n_D , at 25° C	1.5597
Flash point (open cup), °C	96

Procedure. - To measure the cloud point of a test solution, a 30-milliliter sample was placed in the sample tube, stirred, and the temperature was lowered by circulating coolant. The temperature of the sample at which a visual cloud first appeared was recorded as the cloud point. This temperature was quite definite for each sample and was obtained exactly by approaching it from both lower and higher temperatures. Reproducibility of the test data from operator to operator was better than $\pm 1.5^\circ \text{C}$.

RESULTS AND DISCUSSION

Table II lists the cloud points of technical xylidines for various concentrations in the several gasolines indicated.

TABLE II
CLOUD POINT OF TECHNICAL XYLIDINES IN AVIATION GASOLINE

Concentration of xylidines (percent by weight)	Grade 65 as delivered ^a (°C)	Grade 65 extracted ^b (°C)	Grade 65 extracted plus 5 percent mixed aromatics ^c (°C)	Grade 65 extracted plus 10 percent mixed aromatics ^c (°C)	Grade 65 as delivered plus 15 percent mixed aromatics ^c (°C)	Grade 130 as delivered (°C)
3	-----	-62.5	-----	-----	-----	-----
4	-----	-58.5	-----	-----	-----	-----
5	-60.0	-56.0	-----	-----	>-65	>-65
6	-57.5	-----	-----	-----	-----	-----
7	-54.5	-51.0	-60.5	-----	-----	>-65
8	-----	-----	-58.5	-----	-----	-----
8.5	-52.0	-----	-----	-----	-----	-----
10	-49.5	-47.0	-55.0	>-65	-----	>-65

^aContained 4.5 percent aromatics.

^bAromatic-free.

^cMixed aromatics consisted of five parts xylene, one part toluene, and two parts cumene.

Table III lists the solubility of technical xylidines in the various gasolines at -60°C as determined by interpolation of the experimental cloud-point data.

TABLE III
SOLUBILITY OF TECHNICAL XYLIDINES AT -60°C

Fuel	Xylidines (percent by weight)
Grade 65 extracted (aromatic-free)	3.7
Grade 65 as delivered (4.5 percent aromatics)	5.0
Grade 65 extracted plus 5 percent mixed aromatics ^a	7.3
Grade 65 extracted plus 10 percent mixed aromatics ^a	>10.0
Grade 130 as delivered (approx. 15 percent aromatics)	>10.0

^aMixed aromatics consisted of five parts xylene, one part toluene, and two parts cumene.

It is apparent that the solubility of technical xylidines in gasoline increases with increasing content of aromatic hydrocarbons. Furthermore, the greater solubility of xylidines in the extracted grade 65 fuel plus 5 percent of the xylene-toluene-cumene mixture than in the grade 65 fuel as delivered (4.5 percent aromatics, mostly benzene) indicates that the benzene homologues are more effective solubility improvers for xylidines than is benzene alone.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
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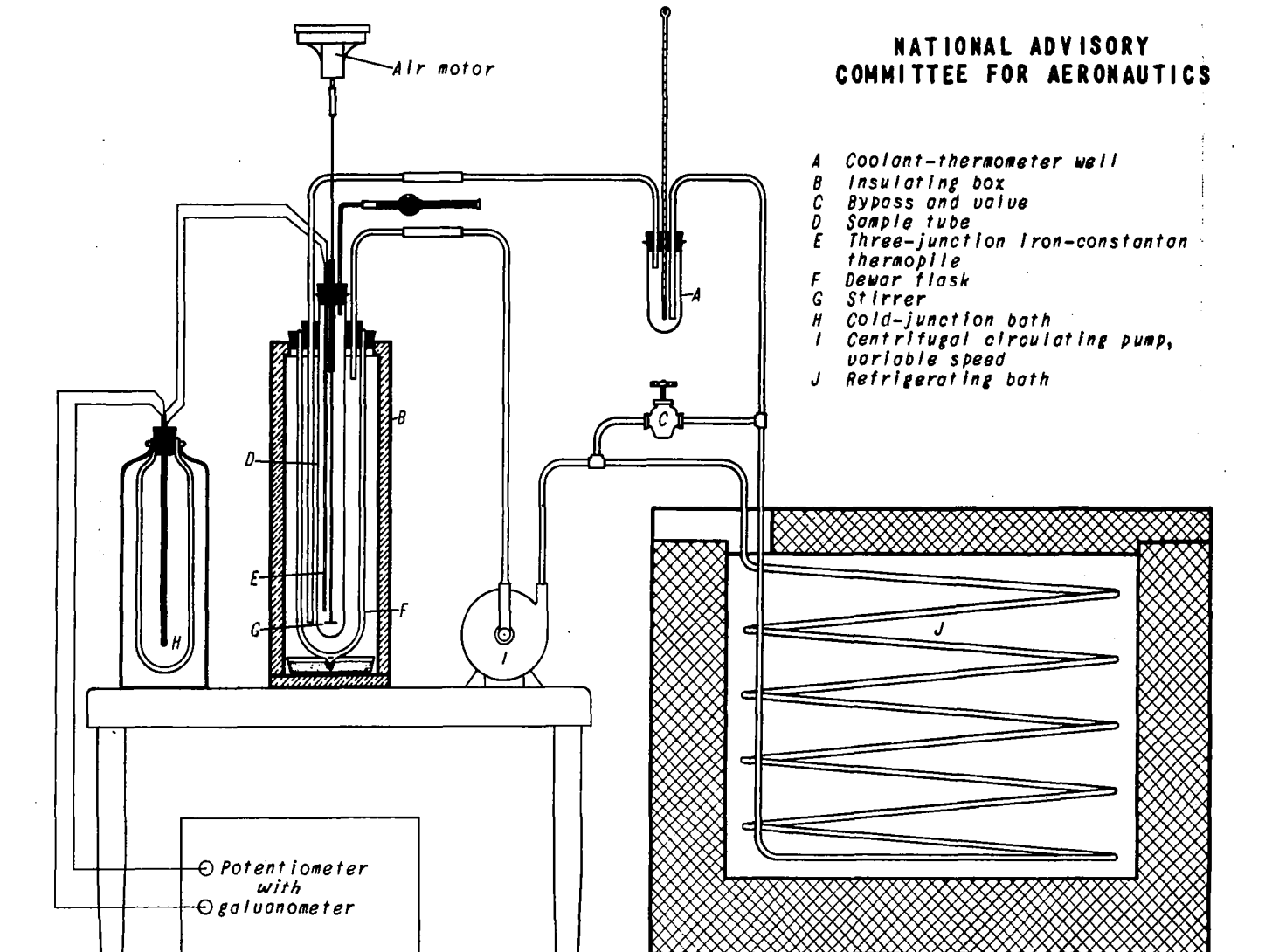


Figure 1. - Cloud-point apparatus.

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